CLAIMS

1. An apparatus for improving Transmission Control Protocol (TCP) performance, the apparatus comprising:

at least one processor;

a memory coupled to the at least one processor; and

an acknowledgment adjuster, the acknowledgment adjuster monitoring network transmission traffic and adjusting use of delayed acknowledgments (ACKs) based on the network transmission traffic.

2. The apparatus of claim 1 wherein the acknowledgment adjuster:

monitors whether an acknowledgment (ACK) was not sent during a predetermined time period after a first packet was received; and

sends an ACK after each received packet if an ACK was not sent during a predetermined time period after a first packet was received.

3. The apparatus of claim 1 wherein the acknowledgment adjuster monitoring network transmission traffic and adjusting use of delayed ACKs further comprises:

the acknowledgment adjuster monitoring packet receipt frequency and adjusting use of delayed ACKs based on packet receipt frequency.

4. The apparatus of claim 1 wherein the acknowledgment adjuster:

determines a time period between when a last ACK for a previous packet was sent and when a current packet is received; and

if the time period between when a last ACK for a previous packet was sent and when a current packet is received is less than a predetermined time period:

discontinues sending an ACK after each received packet; and

sends a delayed ACK after at least one received packet.

5. The apparatus of claim 4 wherein the at least one received packet is the current packet.

6. The apparatus of claim 4 wherein the previous packet and the current packet are full sized packets.

7. The apparatus of claim 1 wherein the acknowledgment adjuster:

determines a time period between when a last ACK was sent and when a data packet is to be sent in return to a previous packet; and

if the time period between when a last ACK was sent and when a data packet is to be sent in return to a previous packet is less than the predetermined time period:

discontinues sending an ACK after each received packet; and

sends a delayed ACK after at least one received packet.

8. The apparatus of claim 1 wherein the acknowledgment adjuster:

upon receiving a current packet determines if the acknowledgment adjuster is to send delayed ACKs after receiving packets, and if the acknowledgment adjuster is to send delayed ACKs after receiving packets;

sends a delayed ACK after receiving at least one packet; or

if the acknowledgment adjuster is to not send delayed ACKs after receiving packets;

sends an ACK after each received packet.

9. The apparatus of claim 2 wherein the acknowledgment adjuster:

determines if a first time period between when a last ACK was sent and when a current packet is received is less than the predetermined time period, and if a first time period between when a last ACK was sent and when a current packet is received is less than the predetermined time period:

discontinues sending an ACK after each received packet; and

sends a delayed ACK after at least one received packet; or

determines if a second time period between when a last ACK was sent and when a data packet is to be sent in return to a current packet is less than the predetermined time period, and if a second time period between when a last ACK was sent and when a data packet is to be sent in return to a current packet is less than the predetermined time period:

discontinues sending an ACK after each received packet; and

sends a delayed ACK after receiving at least one subsequent packet.

10. The apparatus of claim 9 wherein the at least one subsequent packet is the current packet.

11. An apparatus for improving Transmission Control Protocol (TCP) performance, the apparatus comprising:

at least one processor;

a memory coupled to the at least one processor; and

an acknowledgment adjuster, the acknowledgment adjuster monitoring time delays in TCP traffic, these delays occurring between

the last acknowledgment time of a first data packet and receipt of a subsequent data packet, and

the last acknowledgment time of a first data packet and a response data packet sent in reply to a first data packet, and

the receipt of a first data packet and the ACK of that first data packet; and

the acknowledgment adjuster adjusting use of delayed ACKs based on time delays which occur in the TCP traffic such that

if the use of delayed ACKs is disabled and the time delay between the last acknowledgment time and receipt of a subsequent data packet is less than a predetermined time period, use of delayed ACKs is enabled; or

if the use of delayed ACKs is disabled and the time delay between the last acknowledgment time and a reply to the first data packet with a response data packet is less than a predetermined time period, use of delayed ACKs is enabled; or

if the use of delayed ACKs is enabled and the delay in sending an ACK in response to a first data packet exceeds a predetermined time period, use of delayed ACKs is disabled.

12. The apparatus of claim 11 wherein the acknowledgment adjuster

stores the current time as the last acknowledgment time when an ACK is sent in response to a data packet received.

13. The apparatus of claim 11 wherein the acknowledgment adjuster

stores the current time as the last acknowledgment time when an ACK is combined and sent with a response data packet in reply to a first data packet.

14. The apparatus of claim 11 wherein the predetermined time period is 200 milliseconds.

15. The apparatus of claim 11 where the acknowledgment adjuster adjusts use of delayed ACKs based on time delays which occur in the TCP traffic such that if the use of delayed ACKs is disabled and the time delay between the last acknowledgment time and receipt of a subsequent data packet is less than a predetermined time period further:

obtains the difference in time between the last acknowledgment time and the current time when receiving a data packet,

compares that difference in time to a predetermined time period, and

if the difference in time is less than the predetermined time period, uses delayed ACKs on subsequent data packets.

16. The apparatus of claim 11 wherein the acknowledgment adjuster adjusts use of delayed ACKs based on time delays which occur in the TCP traffic such that if the use of delayed ACKs is disabled and the time delay between the last acknowledgment time and a reply to the first data packet with a response data packet is less than a predetermined time period further:

obtains the difference in time between the last acknowledgment time and the current time when a response data packet is to be sent in reply to a previous data packet,

compares that difference in time to a predetermined time period, and

if the difference in time is less than the predetermined time period, enables use of delayed ACKs on subsequent data packets.

17. The apparatus of claim 11 wherein the acknowledgment adjuster adjusts use of delayed ACKs based on time delays which occur in the TCP traffic such that if the use of delayed ACKs is enabled and the delay in sending an ACK in response to a first data packet exceeds a predetermined time period further:

starts a delay timer, set to expire after a predetermine amount of time, when a first data packet is received and acknowledgment of that first data packet is delayed, and

if that delay timer expires, sends an ACK for the first data packet and disables use of delayed ACKs, or

if a subsequent data packet is received before the delay timer expires, clears the delay timer and sends a delayed ACK for both the first data packet and the subsequent data packet, or

if a response data packet is to be sent in reply to a first data packet before the delay timer expires, clears the delay timer and combines and sends a delayed ACK with the response data packet.

18. The apparatus of claim 17 where the acknowledgment adjuster sends a delayed ACK for both the first data packet and the subsequent data packet further:

stores the current time as the last acknowledgment time.

19. The apparatus of claim 17 where the acknowledgment adjuster sends an ACK for the first data packet further:

stores the current time as the last acknowledgment time.

20. The apparatus of claim 17 where the acknowledgment adjuster sends a delayed ACK with the response data packet further:

stores the current time as the last acknowledgment time.

21. The apparatus of claim 17 where the predetermined time period is 200 milliseconds.

22. A method for improving Transmission Control Protocol (TCP) performance, the method comprising the steps of:

monitoring traffic on a TCP connection; and

adjusting use of delayed acknowledgments (ACKs) based on the traffic.

23. The method of claim 22 wherein:

the step of monitoring traffic on a TCP connection comprises the step of determining if an ACK was not sent during a predetermined time period after a first packet was received; and

the step of adjusting use of delayed ACKs based on the traffic comprises the step of sending an ACK after each received packet if an ACK was not sent during a predetermined time period after a first packet was received.

24. The method of claim 22 wherein monitoring traffic on a TCP and adjusting use of delayed ACKs based on the traffic connection further comprises:

monitoring packet receipt frequency on a TCP connection and adjusting use of delayed ACKs based on packet receipt frequency.

25. The method of claim 23 wherein the step of the step of sending an ACK after each received packet if an ACK was not sent during a predetermined time period after a packet was received further comprises the steps of:

determining if a time period between when a last ACK was sent and when a current packet is received is less than the predetermined time period; and

if a time period between when a last ACK was sent and when a current packet is received is less than the predetermined time period:

discontinuing sending an ACK after each received packet; and

sending a delayed ACK after receiving at least one subsequent packet.

26. The method of claim 25 wherein the at least one subsequent packet is the current packet.

27. The method of claim 25 wherein the previous packet and the current packet are full sized packets.

28. The method of claim 23 wherein the step of the step of sending an ACK after each received packet if an ACK was not sent during a predetermined time period after a packet was received further comprises the steps of:

determining a time period between when a last ACK was sent and when a data packet is to be sent in return to a previous packet; and

if a time period between when a last ACK was sent and when a data packet is to be sent in return to a previous packet is less than the predetermined time period:

discontinuing sending an ACK after each received packet; and

sending a delayed ACK after at least one received packet.

29. The method of claim 22 wherein the step of adjusting use of delayed ACKs based on the traffic further comprises:

upon receiving a current packet, determining if the use delayed ACKs is enabled, and if the use of delayed ACKs is enabled;

sending a delayed ACK after receiving at least one packet; or

if the use of delayed ACKs is not enabled;

sending an ACK after each received packet.

30. The method of claim 23 wherein the step of the step of sending an ACK after each received packet if an ACK was not sent during a predetermined time period after a packet was received further comprises the steps of:

determining if a first time period between when a ACK was sent and when a current packet is received is less than the predetermined time period, and if a first time period between when a ACK was sent and when a current packet is received is less than the predetermined time period:

discontinuing sending an ACK after each received packet; and

sending a delayed ACK after at least one received packet; or

determining if a second time period between when a last ACK was sent and when a data packet is to be sent in return to a current packet is less than the predetermined time period, and if a second time period between when a last ACK was sent and when a data packet is to be sent in return to a current packet is less than the predetermined time period:

discontinuing sending an ACK after each received packet; and

sending a delayed ACK after at least one received packet.

31. The method of claim 30 wherein the at least one subsequent packet is the current packet.

32. A method for improving Transmission Control Protocol (TCP) performance, the method comprising the steps of:

monitoring time delays in TCP traffic, these delays occurring between

the last acknowledgment time of a first data packet and receipt of a subsequent data packet, and

the last acknowledgment time of a first data packet and a response data packet sent in reply to a first data packet, and

the receipt of a first data packet and the acknowledgment of that first data packet; and

adjusting use of delayed ACKs based on time delays which occur in the TCP traffic such that

if the use of delayed ACKs is disabled and the time delay between the last acknowledgment time and receipt of a subsequent data packet is less than a predetermined time period, use of delayed ACKs is enabled; or

if the use of delayed ACKs is disabled and the time delay between the last acknowledgment time and a reply to the first data packet with a response data packet is less than a predetermined time period, use of delayed ACKs is enabled; or

if the use of delayed ACKs is enabled and the delay in sending an ACK in response to a first data packet exceeds a predetermined time period, use of delayed ACKs is disabled.

33. The method of claim 32 wherein the step of monitoring time delays in TCP traffic further comprises

storing the current time as the last acknowledgment time when an ACK is sent in response to a data packet received.

34. The method of claim 32 wherein the step of monitoring time delays in TCP traffic further comprises

storing the current time as the last acknowledgment time when an ACK is combined and sent with a response data packet in reply to a first data packet.

35. The method of claim 32 wherein the predetermined time period is 200 milliseconds.

36. The method of claim 32 wherein the step of adjusting use of delayed ACKs based on time delays which occur in the TCP traffic such that if the use of delayed ACKs is disabled and the time delay between the last acknowledgment time and receipt of a subsequent data packet is less than a predetermined time period further comprises:

obtaining the difference in time between the last acknowledgment time and the current time when receiving a data packet,

comparing that difference in time to a predetermined time period, and

if the difference in time is less than the predetermined time period, enable the use of delayed ACKs on subsequent data packets.

37. The method of claim 32 wherein the step of adjusting use of delayed ACKs based on time delays which occur in the TCP traffic such that if the use of delayed ACKs is disabled and the time delay between the last acknowledgment time and a reply to the first data packet with a response data packet is less than a predetermined time period further comprises:

obtaining the difference in time between the last acknowledgment time and the current time when a response data packet is to be sent in reply to a previous data packet,

comparing that difference in time to a predetermined time period, and

if the difference in time is less than the predetermined time period, enable the use of delayed ACKs on subsequent data packets.

38. The method of claim 32 wherein the step of adjusting use of delayed ACKs based on time delays which occur in the TCP traffic such that if the use of delayed ACKs is enabled and the delay in sending an ACK in response to a first data packet exceeds a predetermined time period further comprises:

starting a delay timer, set to expire after a predetermine amount of time, when a first data packet is received and acknowledgment of that first data packet is delayed, and

if that delay timer expires, sending an ACK for the first data packet and disabling use of delayed ACKs, or

if a subsequent data packet is received before the delay timer expires, clearing the delay timer and sending a delayed ACK for both the first data packet and the subsequent data packet, or

if a response data packet is to be sent in reply to a first data packet before the delay timer expires, clearing the delay timer and combining and sending a delayed ACK with the response data packet.

39. The method of claim 38 wherein the step of sending a delayed ACK for both the first data packet and the subsequent data packet further comprises:

storing the current time as the last acknowledgment time.

40. The method of claim 38 wherein the step of sending an ACK for the first data packet further comprises:

storing the current time as the last acknowledgment time.

41. The method of claim 38 wherein the step of combining and sending a delayed ACK with the response data packet further comprises:

storing the current time as the last acknowledgment time.

42. The method of claim 38 wherein the predetermined time period is 200 milliseconds.

43. A program product, tangibly embodying a program of machine-readable instructions executable by a computer system, the program product comprising:

an acknowledgment adjuster program, the acknowledgment adjuster program monitoring traffic on a TCP connection and adjusting the use of delayed ACKs based on the traffic; and

signal bearing media bearing the acknowledgment adjuster program.

44. The program product of claim 43 wherein the signal bearing media comprises transmission media.

45. The program product of claim 43 wherein the signal bearing media comprises recordable media.

46. The program product of claim 43 wherein the acknowledgment adjuster program monitoring traffic on a TCP connection and adjusting the use of delayed ACKs based on the traffic further comprises:

the acknowledgment adjuster program monitoring packet receipt frequency on a TCP connection and adjusting the use of delayed ACKs based on the packet receipt frequency.

47. The program product of claim 43 wherein the acknowledgment adjuster program:

monitors whether an ACK was not sent during a predetermined time period after a first packet was received; and

sends an ACK after each received packet if an ACK was not sent during a predetermined time period after a first packet was received.

48. The program product of claim 43 wherein the acknowledgment adjuster program:

determines a time period between when a last ACK for a previous packet was sent and when a current packet is received; and

if the time period between when a last ACK for a previous packet was sent and when a current packet is received is less than a predetermined time period:

discontinues sending an ACK after each received packet; and

sends a delayed ACK after at least one received packet.

49. The program product of claim 48 wherein the at least one received packet is the current packet.

50. The program product of claim 48 wherein the previous packet and the current packet are full sized packets.

51. The program product of claim 43 wherein the acknowledgment adjuster program:

determines a time period between when a last ACK was sent and when a data packet is to be sent in return to a previous packet; and

if the time period between when a last ACK was sent and when a data packet is to be sent in return to a previous packet is less than the predetermined time period:

discontinues sending an ACK after each received packet; and

sends a delayed ACK after at least one received packet.

52. The program product of claim 43 wherein the acknowledgment adjuster program:

upon receiving a current packet determines if the acknowledgment adjuster program is to send delayed ACKs after receiving packets, and if the acknowledgment adjuster program is to send delayed ACKs after receiving packets;

sends a delayed ACK after receiving at least one packet; or

if the acknowledgment adjuster program is to not send delayed ACKs after receiving packets;

sends an ACK after each received packet.

53. The program product of claim 47 wherein the acknowledgment adjuster program:

determines if a first time period between when a last ACK was sent and when a current packet is received is less than the predetermined time period, and if a first time period between when a last ACK was sent and when a current packet is received is less than the predetermined time period:

discontinues sending an ACK after each received packet; and

sends a delayed ACK after at least one received packet; or

determines if a second time period between when a last ACK was sent and when a data packet is to be sent in return to a current packet is less than the predetermined time period, and if a second time period between when a last ACK was sent and when a data packet is to be sent in return to a current packet is less than the predetermined time period:

discontinues sending an ACK after each received packet; and

sends a delayed ACK after receiving at least one subsequent packet.

54. The program product of claim 53 wherein the at least one subsequent packet is the current packet.

55. A program product, tangibly embodying a program of machine-readable instructions executable by a computer system, the program product comprising:

an acknowledgment adjuster program, the acknowledgment adjuster program monitoring time delays in TCP traffic, these delays occurring between

the last acknowledgment time of a first data packet and receipt of a subsequent data packet, and

the last acknowledgment time of a first data packet and a response data packet sent in reply to a first data packet, and

the receipt of a first data packet and the ACK of that first data packet; and

the acknowledgment adjuster program adjusting use of delayed ACKs based on time delays which occur in the TCP traffic such that

if the use of delayed ACKs is disabled and the time delay between the last acknowledgment time and receipt of a subsequent data packet is less than a predetermined time period, use of delayed ACKs is enabled; or

if the use of delayed ACKs is disabled and the time delay between the last acknowledgment time and a reply to the first data packet with a response data packet is less than a predetermined time period, use of delayed ACKs is enabled; or

if the use of delayed ACKs is enabled and the delay in sending an ACK in response to a first data packet exceeds a predetermined time period, use of delayed ACKs is disabled.

56. The program product of claim 55 wherein the signal bearing media comprises transmission media.

57. The program product of claim 55 wherein the signal bearing media comprises recordable media.

58. The program product of claim 55 wherein the acknowledgment adjuster program

stores the current time as the last acknowledgment time when an ACK is sent in response to a data packet received.

59. The program product of claim 55 wherein the acknowledgment adjuster program

stores the current time as the last acknowledgment time when an ACK is combined and sent with a response data packet in reply to a first data packet.

60. The program product of claim 55 wherein the predetermined time period is 200 milliseconds.

61. The program product of claim 55 where the acknowledgment adjuster program adjusts use of delayed ACKs based on time delays which occur in the TCP traffic such that if the use of delayed ACKs is disabled and the time delay between the last acknowledgment time and receipt of a subsequent data packet is less than a predetermined time period further:

obtains the difference in time between the last acknowledgment time and the current time when receiving a data packet,

compares that difference in time to a predetermined time period, and

if the difference in time is less than the predetermined time period, uses delayed ACKs on subsequent data packets.

62. The program product of claim 55 wherein the acknowledgment adjuster program adjusts use of delayed ACKs based on time delays which occur in the TCP traffic such that if the use of delayed ACKs is disabled and the time delay between the last acknowledgment time and a reply to the first data packet with a response data packet is less than a predetermined time period further:

obtains the difference in time between the last acknowledgment time and the current time when a response data packet is to be sent in reply to a previous data packet,

compares that difference in time to a predetermined time period, and

if the difference in time is less than the predetermined time period, enables use of delayed ACKs on subsequent data packets.

63. The program product of claim 55 wherein the acknowledgment adjuster program adjusts use of delayed ACKs based on time delays which occur in the TCP traffic such that if the use of delayed ACKs is enabled and the delay in sending an ACK in response to a first data packet exceeds a predetermined time period further:

starts a delay timer, set to expire after a predetermine amount of time, when a first data packet is received and acknowledgment of that first data packet is delayed, and

if that delay timer expires, sends an ACK for the first data packet and disables use of delayed ACKs, or

if a subsequent data packet is received before the delay timer expires, clears the delay timer and sends a delayed ACK for both the first data packet and the subsequent data packet, or

if a response data packet is to be sent in reply to a first data packet before the delay timer expires, clears the delay timer and combines and sends a delayed ACK with the response data packet.

64. The program product of claim 63 where the acknowledgment adjuster program sends a delayed ACK for both the first data packet and the subsequent data packet further:

stores the current time as the last acknowledgment time.

65. The program product of claim 63 where the acknowledgment adjuster program sends an ACK for the first data packet further:

stores the current time as the last acknowledgment time.

66. The program product of claim 63 where the acknowledgment adjuster program sends a delayed ACK with the response data packet further:

stores the current time as the last acknowledgment time.

67. The program product of claim 63 where the predetermined time period is 200 milliseconds.

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